Kettle Tri-Watershed Quality Assurance Project Plan
Grant Number G0000145

February 28, 2000

Grantee:

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PROJECT DESCRIPTION

History

Lambert, Lone Ranch and St. Peter Creeks are located on the west flank of the northern portion of the Kettle Range of mountains. Lone Ranch Creek flows directly into the Kettle River, while Lambert and St. Peter Creeks flow into Curlew Creek, which in turn flows into the Kettle River. Elevation on the three streams ranges from 7,000 feet at the headwaters to 1,800 feet at confluence with the Kettle River. Approximately 80% of Lone Ranch Creek and over 60% of St. Peter and Lambert Creek watersheds are within the Colville National Forest. Each of the watersheds is roaded and utilized for recreation, timber resources, cattle grazing allotments, and rural development on the lower reaches (private homes with septic systems).

All three streams are currently listed on the Clean Water Act 303 (d) list as exceeding criterion set by the Washington Department of Ecology for fecal coliform bacteria. Listings are based on water samples gathered at a limited number of sites by the Colville National Forest. Table 1 lists state criteria for water quality standards in the affected area. Tables 2 through 6 provide a summary and range of specific water quality parameters provided by the Colville National Forest Supervisors Office for all three watersheds. Curry Jones of the Environmental Protection Agency reported this sample data to the Washington Department of Ecology on November 22, 1995.

Table 1. State criteria for water quality parameters provided by the Department of Ecology.

Parameter	State standards for class AA (extraordinary) surface waters
Fecal Coliform (colonies/100 ml)	Geometric mean < 50 colonies/100 ml and no more than 10% of all samples shall exceed 100 colonies/100 ml
Flow (cfs)	--------------------
Dissolved Oxygen (mg/L)	DO > 9.5 mg/l and < 110% saturation
pH	Range between 6.5 - 8.5
Total Dissolved Solids (mg/L)	-------------
Water Temperature (°C)	Not to exceed 16 (°C) / 60.8 (°F)
Turbidity (NTU)	< 5.0 NTU over background turbidity when background turbidity is 50 NTU or less

Table 2. Summary of water quality data provided by Colville National Forest for Lambert Creek from 1991, 1992, and 1998.

Parameter	Number of Samples	Min	Max	Average
Fecal Coliform (colonies/100 ml) Samples with > 100 colonies/100 ml	22 3 (13.64%)	0	416	27*
Flow (cfs)	10	1.17	35.56	13.63
Dissolved Oxygen (mg/L)	1	---	---	10.4
pH	19	7.35	8.37	8.06
Total Dissolved Solids (mg/L)	19	30	150	100
Water Temperature (°C)	26	3.0	15.0	9.8
Turbidity (NTU)	19	0.35	10.0	2.29
*geometric mean				

Table 3. Summary of water quality data provided by Colville National Forest for North Fork Lone Ranch Creek from 1991, 1992, 1995, 1997, and 1998.

Parameter	Number of Samples	Min	Max	Average
Fecal Coliform (colonies/100 ml) Samples with > 100 colonies/100 ml	41 10(24.39%)	0	400	26*
Flow (cfs)	14	0.38	18.87	3.97
Dissolved Oxygen (mg/L)	6	9.0	11.4	10.2
pH	29	7.67	8.54	8.18
Total Dissolved Solids (mg/L)	31	30	225	138
Water Temperature (°C)	45	3.0	14.0	10.5
Turbidity (NTU)	41	0.28	23.00	2.36
*geometric mean				

Table 4. Summary of water quality data provided by Colville National Forest for South Fork Lone Ranch Creek from 1991, 1992, 1995, 1997, and 1998.

Parameter	Number of Samples	Min	Max	Average
Fecal Coliform (colonies/100 ml) Samples with > 100 colonies/100 ml	39 8 (20.51%)	0	624	17*
Flow (cfs)	19	0.67	17.60	5.77
Dissolved Oxygen (mg/L)	8	9.0	11.4	10.2
pH	28	7.67	8.54	8.18
Total Dissolved Solids (mg/L)	28	30	225	138
Water Temperature (°C)	41	3.0	14.0	10.5
Turbidity (NTU)	28	0.16	23.00	3.36
*geometric mean				

Table 5. Summary of water quality data provided by Colville National Forest for North Fork St. Peter Creek from 1991, 1992, and 1995.

Parameter	Number of Samples	Min	Max	Average
Fecal Coliform (colonies/100 ml) Samples with > 100 colonies/100 ml	32 4 (12.5%)	2	525	29*
Flow (cfs)	3	2.10	5.86	3.67
Dissolved Oxygen (mg/L)	0	----	----	------
pH	13	7.71	8.19	7.79
Total Dissolved Solids (mg/L)	13	45	150	107
Water Temperature (°C)	17	4.0	13.0	9.5
Turbidity (NTU)	13	0.23	14.00	2.49
*geometric mean				

Table 6. Summary of water quality data provided by Colville National Forest for South Fork St. Peter Creek from 1991, 1992, and 1998.

Parameter	Number of Samples	Min	Max	Average
Fecal coliform (colonies/100 ml) Samples with > 100 colonies/100 ml	23 4 (17.39%)	0	643	9*
Flow (cfs)	9	0.39	13.69	5.02
Dissolved Oxygen (mg/L)	1	-----	11.2	------
pH	15	7.81	8.42	8.23
Total Dissolved Solids (mg/L)	15	40	225	157
Water Temperature (°C)	25	4.0	16.0	7.6
Turbidity (NTU)	15	0.24	6.00	1.79
*geometric mean				

Washington State uses fecal coliform bacteria as an indicator of fecal contamination. The presence of fecal coliform bacteria in water samples may indicate the presence of more harmful pathogens. Coliform bacteria are generally found in the intestinal tract of warm-blooded animals. Therefore, possible sources of fecal coliform contamination includes animal waste in surface water runoff, untreated human waste, and animal waste deposited directly in-stream (i. e., beaver and waterfowl waste). In the past, investigators have found it difficult to identify specific sources of fecal coliform contamination (Sargeant, 1999).

Concentrations of domestic animals in a watershed have been identified as a likely source of coliform contamination (Horne & Goldman, 1994). According to the *Lone-Deer Ecosystem Analysis* published by the Colville National Forest, water samples submitted to the Department of Ecology were taken from one sampling site per stream and no more than two sites per watershed. On both forks of Lone Ranch

Creek, these sites are on the Forest Service boundary line where cattle tend to congregate. Thus, sample results may be affected by local heavy cattle usage and cannot be used to characterize the water quality of the entire watershed (Republic Ranger District, Colville National Forest, 1998). Similar sampling techniques were used on Lambert and St. Peter Creeks. A thorough monitoring evaluation of fecal coliform presence and associated water quality parameters has not been conducted due to lack of monitoring funds.

In 1998, the Upper Columbia Resource Council (UCRC) drafted a letter to the Colville National Forest calling for a more comprehensive study of watersheds affected by the 303 (d) listings. The lack of adequate data has created polarization between the USFS with its need to provide water quality protection management, and private citizens who desire to use roads, harvest timber, and use grazing allotments. At this time, the UCRC and local ranchers approached the Ferry Conservation District with seed money to conduct a comprehensive water quality study that includes an innovative and scientifically sound method of fecal coliform source tracking through DNA analysis.

The Ferry Conservation District believes that this is an excellent opportunity to establish agency and private citizen cooperation to specifically improve the water quality and overall management of these three watersheds. The establishment of such a co-management team will provide Ferry County with future contributors to water quality improvement, and education on other 303 (d) listed water bodies. Therefore, the purpose of this project is to conduct water quality monitoring (including fecal coliform source tracking DNA analysis providing specific characterization of what is otherwise considered to be a nonpoint source) and design, adopt, and implement on-the-ground and policy Best Management Practices. The intent is to remove each of these watersheds from the 303 (d) list. The cooperative Kettle Tri-Watershed Management Team (KTWMT) will provide guidance of all project efforts, participate in monitoring efforts, and help implement Best Management Practices.

Problem Statements

The proceeding information has been summarized into three problem statements specifically addressed by the project objectives.

1. Data is needed, and is lacking, to provide a baseline for future reference, to develop relationships between factors affecting water quality, to characterize the overall water quality of these three watersheds, to identify areas of concern to management, and develop and implement best management practices.

2. At present, no procedure exists for tracking local sources of fecal contamination.

3. No formal setting exists where private citizens and public land managers can cooperate in gathering water quality data and making management decisions affecting water quality and land usage in the three watersheds.

Specific Objectives

1. Establishment of the Kettle Tri-Watershed Management Team.

2. Successful demonstration of a scientifically sound, innovative, DNA analysis methodology for determining animal species sources and their relative percentages of fecal coliform contamination of water, and establishing a fecal coliform source DNA library.

3. Comprehensive characterization of overall water quality by quantitative monitoring of parameters including fecal coliform, temperature, nitrogen compounds, total phosphorous, dissolved oxygen, pH, conductivity, turbidity and discharge flow.

4. Inventory and survey existing riparian and upland conditions and practices affecting water quality.

5. The data generated by this project, if needed, will be used by local citizens, the Ferry Conservation District, and the Department of Ecology to implement Best Management Practices (BMP's) in an effort to bring affected water bodies within compliance of State water quality standards. The data may also be used to submit a Total Maximum Daily Load (TMDL) report to the Environmental Protection Agency with a recommendation for these water bodies to be removed from the 303(d) list.

6. Leveraging of grant BMP "seed" funds by active solicitation of affected agencies and citizens to contribute needed funding and resources to complete selected BMP's.

Site Description and Project Design

In order to meet the objectives of the project, water sampling stations will be established on each stream to capture the effects of land-use practices. Each stream will be further segmented into primary reaches based on changes in channel/valley bottom type, and the influence of major tributaries. Upland conditions effecting water quality include road conditions, and hydrologic features of the watersheds. The following discussion provides a detailed description of the study area, water sampling stations, and stream reach segmentation.

Lambert, Lone Ranch, and St. Peters creeks drain the west flank of the Kettle Range of mountains. These streams recharge shallow alluvial aquifers from which many private landowners draw their water. Annual precipitation varies from 15 inches at the mouths of the streams to 35 inches at the headwaters. The upper watersheds lie within the Colville National Forest where primary land use consists of cattle grazing allotments, timber management, wildlife habitat, and recreation. The lower reaches of each watershed are privately owned. Primary land use in these areas consists of rural development, domestic grazing, hay and alfalfa cultivation, wildlife habitat, and timber management. Characteristic and beneficial water uses in all three watersheds include: a source of water supply for domestic, and agricultural uses; stock watering; fish migration, rearing, and spawning; wildlife habitat; recreation; commerce.

The Copper Butte fire of 1994 burned a high percentage of the canopy cover in the headwaters of Lambert Creek. Approximately 10 – 20 % of the headwater area of St. Peters Creek was burned in the same fire. This fire event has been associated with the floods of 1998 when Lambert Creek was blown out. The South Fork of St. Peters creek still has steep valleys with fire scared and dead trees.

Water Sampling Stations

Water samples will be analyzed for nutrients, pH, turbidity, conductivity, dissolved oxygen, fecal coliform, and flow. Due to size and density, large herbivorous animals are considered a likely source of fecal material. Animals of this type within the study area include cattle, horses, sheep, goats, and deer. Steve Zender, state wildlife biologist, estimates that there are approximately 7.5 deer per square mile in the study area. Seasonal movement and migration patterns will determine where these animals are located within the watershed at any given time.

Other animals, due to their habit of foraging and living in areas directly in or adjacent to water sources, can influence fecal coliform concentrations. Animals of this description found in northern Ferry County include muskrat, beaver, waterfowl, and raccoon. Muskrat and waterfowl can be eliminated from the scope of this study due to lack of adequate habitat. At present, it is not known how many beaver and raccoons are using the streams.

Human influence on land-use practices effecting water quality is more likely to be seen in areas of rural development. Potential sources of water quality degradation in these areas include leaky septic systems, the presence of domestic animals (many private landowners keep cows, sheep, horses, goats, and dogs in pastures along the streams), and wildlife.

Lambert Creek

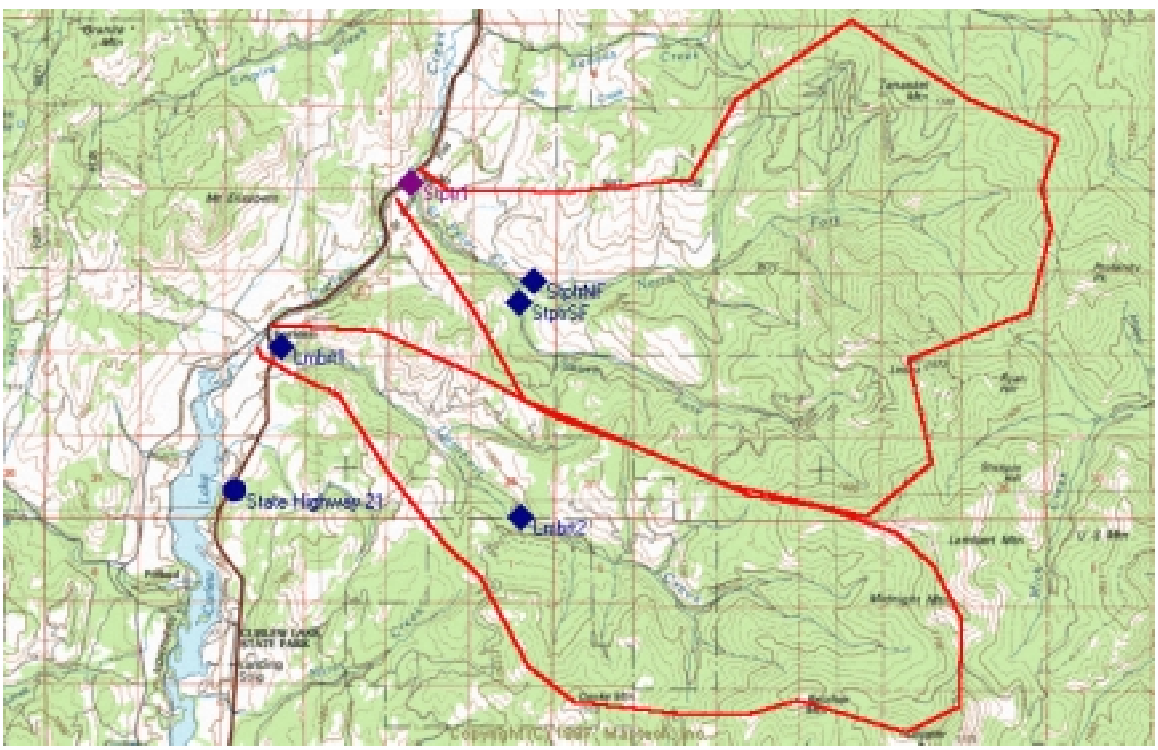
Lambert Creek crosses under state highway 21 and enters Curlew Creek 9.5 miles north of the intersection of state highways 20 and 21 just east of the town of Republic, Washington. Legal location: Township 38 North, Range 33 East, Section

21. The Lambert Creek watershed encompasses 8,731 acres. Approximately 31% of this area lies within the Colville National Forest.

From June 1 to August 15, there are approximately 360 cattle on national forest land within the Lambert Creek watershed. After August 15, 211 of these cows are pushed east over the Kettle crest and out of the watershed. The remaining cows are moved off federal land by October 4. Additional cattle are kept on private lands. At an estimated 7.5 deer per square mile, there may be up to 102 deer within the watershed at any given time. There are an estimated 49 private landowners along the lower reaches of the watershed. According to the North East Tri-County Health District, there are 39 on-site septic (OSS) permits on private land.

Water sampling station Lmbrt1 (see map 1) will be established near the mouth of Lambert Creek to capture the cumulative effects of land use practices on the lower reaches of the watershed. Sampling station Lmbrt2, located approximately 4.2 miles up Lambert Creek on the National Forest boundary, will capture the cumulative effects of land use practices in the upper reaches where the effects of human influence are less likely to be seen.

Map 1: Lambert and St. Peters Creek water sampling stations.



St. Peters Creek

St. Peters Creek crosses under state highway 21 and enters Curlew Creek 2.8 miles north of Lambert Creek. Legal location: Township 38 North, Range 33 East, Section 11. St. Peters Creek watershed encompasses 17,690 acres. Approximately 60% of this area lies within the Colville National Forest.

There are two separate cattle grazing allotments on federal land within the St. Peters watershed. From June 1 to October 15 each year, there are 154 cattle utilizing the grazing units within the South Fork St. Peters allotment. The North Fork St. Peters grazing allotment has a shorter season with 139 cattle in the area from June 1 to September 30. Additionally, there are an estimated 207 deer within the boundaries of St. Peters watershed, and estimated 32 private landowners on the lower reaches. Tri-County Health reports 27 OSS permits on private lands.

Water sampling station Stptr1 (see map 1) will be established near the mouth of St. Peters Creek to capture the cumulative effects of land use practices on the lower reaches. Sampling stations StptrNF and StptrSF are located approximately 2.2 miles from the mouth on each fork of St. Peters Creek. Land use practices on the upper reaches are similar to Lambert Creek.

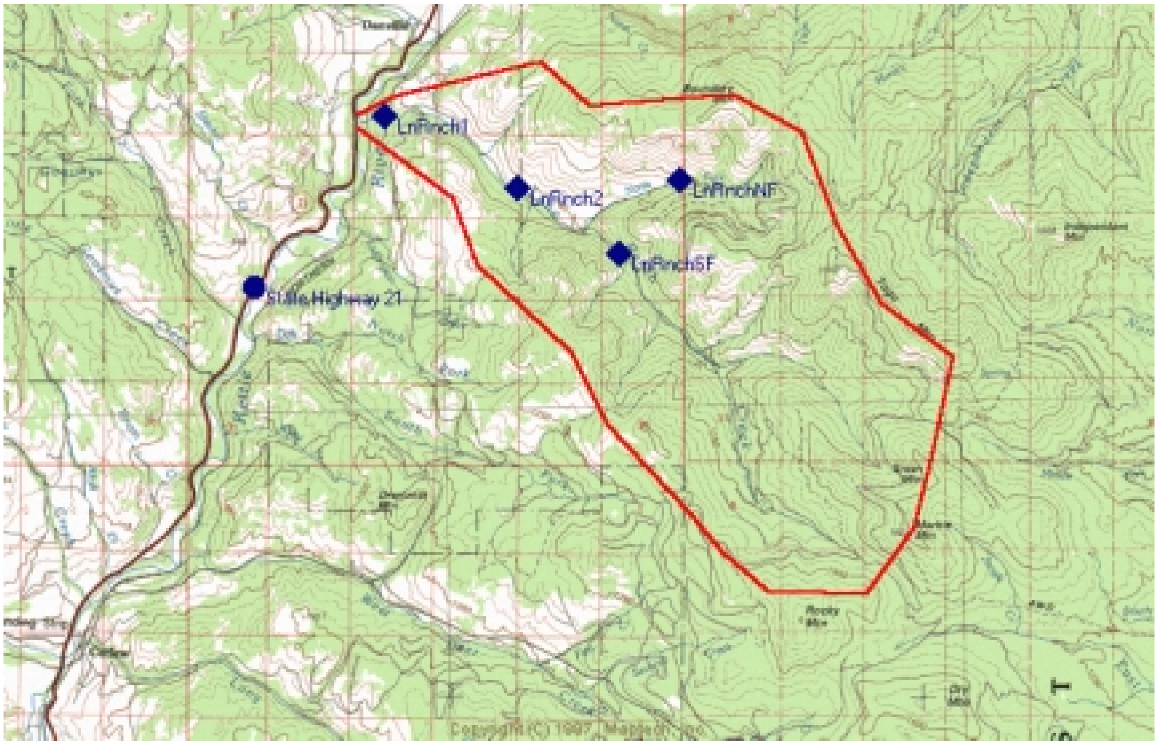
Lone Ranch Creek

Lone Ranch Creek enters the Kettle River 2.3 miles south of the Canadian border on state Highway 21. Legal location: Township 40 North, Range 34 East, Section 9. The Lone Ranch Creek watershed encompasses 14,714 acres. Approximately 70% of this area lies within the Colville National Forest.

From June 1 to October 31, there are 231 cattle within the Lone Ranch allotment on federal land. Grumbach and Sons keep about 20 head of cattle on private land within the watershed during winter months. Approximately 20 water developments have been established within this allotment that are designed to provide cattle with water source away from the stream. Due to lower density of rural development, (the estimated number of landowners is 9) deer densities are expected to be higher than Lambert or St. Peters (175 to 200 deer total). Tri-County Health reports 10 OSS permits on private lands.

Four water sampling stations will be established on Lone Ranch Creek. The first, LnRnch1 (see map 2), will be placed near the mouth to capture the cumulative effects of land use practices on the lower reaches. Dog kennels placed near the stream are a possible source of fecal material in this area. A water sampling station (LnRnchSF) will be placed on the South Fork Lone Ranch Creek just above its confluence with main Lone Ranch. Land use practices in this area are similar to the upper reaches of Lambert and St. Peters Cr. Water sampling stations (LnRnchNF and LnRnch2) will be placed above and below Grumbach and Son's Ranch. Land use practices in this area include cattle grazing and irrigated alfalfa cultivation.

Map 2: Lone Ranch Creek water sampling stations.



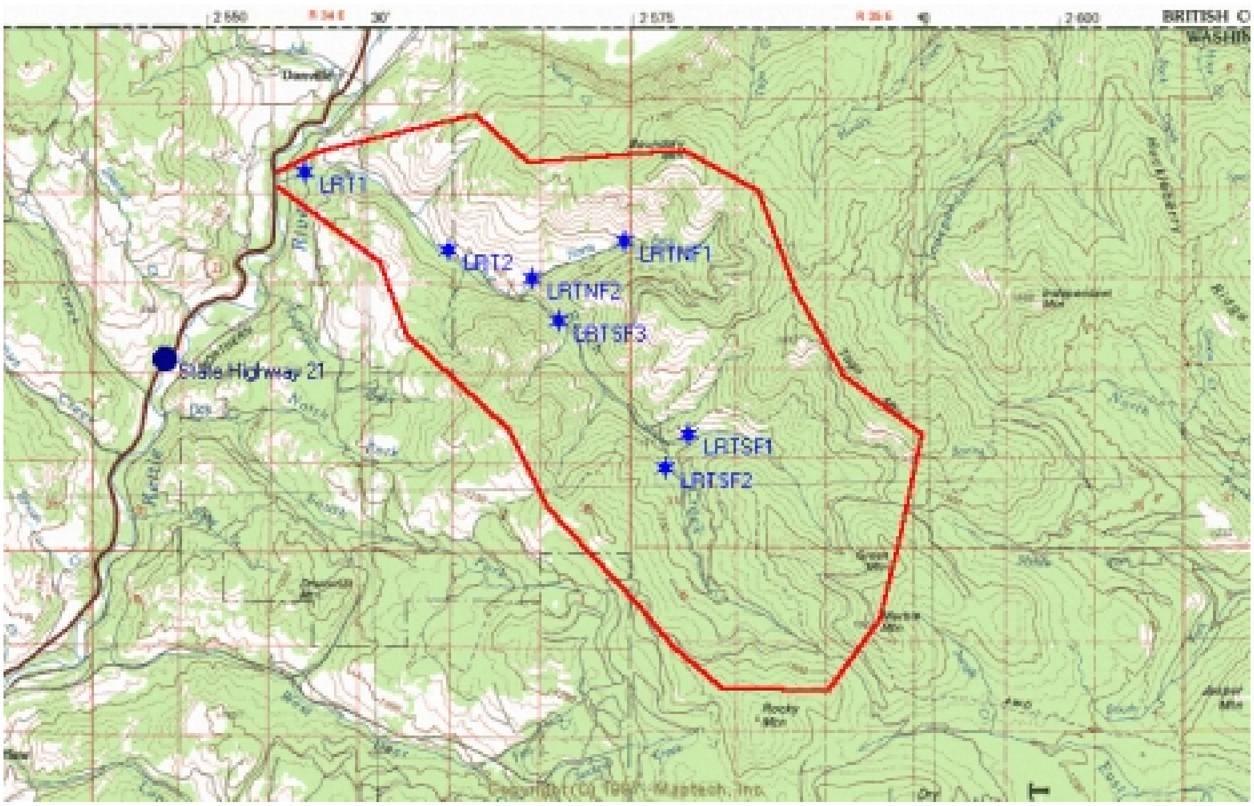
Stream Segmentation

Each stream will be segmented based on primary land-use for water quality sampling, thermal reaches for temperature monitoring, and Rosgen (1994) channel type for riparian surveys. A thermal reach consists of a section of stream influenced by factors affecting in-stream temperatures. In-stream temperature monitoring devices will be placed at the bottom of each reach to record temperatures throughout the entire monitoring season. Temperatures will be compared to canopy cover readings (% cover), stream aspect, land type associations, elevation, air temperature, and soil temperature, as these factors have been shown to influence temperatures on other streams within Ferry County.

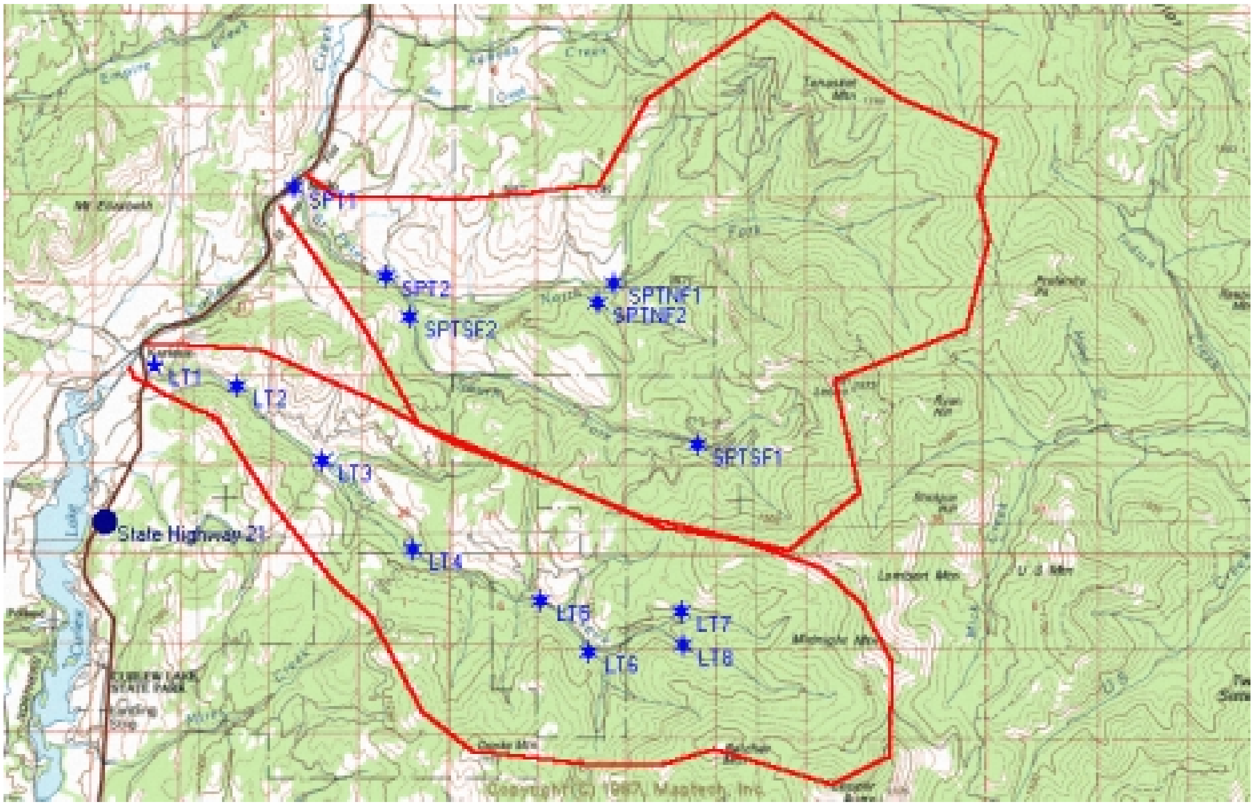
Riparian conditions will be surveyed and described for each reach using *Riparian Area Management: Process for Assessing Proper functioning Condition* published by the US Department of the Interior Bureau of Land Management (1993). This process will fit this study well due to its interdisciplinary team approach to riparian area assessment. Private landowners will be able to participate in the assessment by inventorying and monitoring vegetation, erosion, and water quality components. The assessment is accepted by the USDA Forest Service, comparable to data collected in the past, and consistent with current voluntary vegetative stubble height monitoring programs.

Instantaneous stream flow measurements will be taken on the same days that water samples are gathered using a current meter. This information will be used to estimate stream discharge, and will be compared with precipitation measurements and water quality parameters. Discharge measurements will be taken near the mouths of each stream. Rain gauges will be voluntarily placed and monitored on private lands within the lower reaches of each watershed.

Map 3. Stream reach segmentation and temperature logger location for Lone Ranch Creek.



Map 4. Stream reach segmentation and temperature logger location for Lambert and St. Peters Creeks.



Schedule

Tentative dates have been set for water sampling, and riparian and upland surveys in the following table. In general, routine sampling of fecal coliform, flow, temperature, pH, conductivity, dissolved oxygen, turbidity, will be collected and analyzed twice/month. Nutrient sampling once/month will be sufficient to characterize each watershed. Riparian and upland surveys will be conducted during the summer months when vegetation is green and growing.

Training sessions dealing with water sampling will take place in mid April, before actual sampling begins. Range, riparian, and upland survey training will be conducted in the last weeks of May and throughout the summer as needed. Actual range, riparian, and upland surveys will be conducted during the summer of 2000. The Kettle Tri-Watershed management team will meet monthly beginning in February.

Table 7. Tentative routine parameter and nutrient sampling schedule

Date	Routine Parameters	Nutrients
May 1, 2000	X	X
May 15, 2000	X	
June 5, 2000	X	X
June 19, 2000	X	
July 10, 2000	X	X
July 24, 2000	X	
August 7, 2000	X	X
August 21, 2000	X	
September 11, 2000	X	X
September 25, 2000	X	
October 16, 2000	X	X
October 30, 2000	X	
November 6, 2000	X	X
November 20, 2000	X	
December 4, 2000	X	X
December 18, 2000	X	
January 8, 2001	X	X
January 22, 2001	X	
February 5, 2001	X	X
February 26, 2001	X	
March 12, 2001	X	X
March 26, 2001	X	
April 9, 2001	X	X
April 23, 2001	X	
May 7, 2001	X	X
May 21, 2001	X	
June 11, 2001	X	X
June 25, 2001	X	

Organization

Ferry Conservation District is responsible for the implementation of the Kettle Tri-Watershed project, grant number G0000145. The District is responsible for forming and facilitating the Kettle Tri-Watershed Management Team (KTWMT), and contracting with Department of Ecology certified laboratories to analyze water samples for fecal coliform concentration. The District will collect, transport, organize, store, and report all related data. Sampling results will be summarized and submitted to the District Board of Supervisors for review and approval at monthly board meetings. Jean Parodi, Project Manager, will receive a quarterly data summary and project report to review and approve. Chris Tretter, Water Resource Specialist, and/or Randy Williams, District Manager, are the contact persons for the District.

The KTWMT will meet monthly starting February 9, 2000. The team will consist of representatives from state and local agencies, local organizations, and local private landowners who have a vested interest in the area. Having local knowledge of the study area, the team will provide guidance and insight in developing the sampling network, gathering sample data, and implementing the specific objective of the project. The recommendations generated by the KTWMT will be brought before the District Board of Supervisors and Jean Parodi for final review and approval. Meeting development guidelines, and a form for assessing the effectiveness of meetings has been included in appendix B.

In generating recommendations, there may exist a difference of opinion between representatives. In this case, the matter will be settled by a majority vote. To provide balance between agency representatives and private landowners, the District has invited two private landowners to represent each watershed, and two at-large representatives consisting of private landowners outside the study area yet within the Kettle River watershed (see appendix A for letters to local landowners and agencies). ***Each agency, even though represented by more than one person, will be allowed one vote. For example, the Natural Resources Conservation Service, even though represented by four persons, will carry only one vote.***

The limnology laboratory at Eastern Washington University will receive water samples to analyze fecal coliform concentrations, and provide a nutrient analysis. Linda Sexton, Laboratory Manager, will process the results and report findings to the Ferry Conservation District. The cultured fecal coliform colonies themselves will be categorized by sample site and sent to Dr. Samadpour at the University of Washington.

Fecal samples will be gathered in the field and categorized by watershed and animal source. Dr. Samadpour will receive the fecal samples and develop a fecal coliform DNA source library. The library will allow a person to derive the relative percentage of fecal coliform contribution by animal species from a particular watershed when analyzing water samples. The results of the fecal coliform source tracking will be delivered to the Ferry Conservation District.

Table 8. KTWMT representatives and organization.

Kettle Tri-Watershed Management Team		
Lone Ranch Creek Landowners		
Doug Grumbach		(509) 779-4839
Harold Martz		(509) 775-3695
St. Peter Creek Landowners		
Jack McClellan		(509) 779-4306
Lee Ahlers		(509) 779-4084
Lambert Creek Landowners		
Marshall Brantley		(509) 775-2026
Patti Furman		(509) 775-2548
Kettle Tri- Watershed At-Large Representatives		
Reese Sebree		(509) 779-4760
John Brucklier		(509) 779-4379
Organization/Company Representatives		
Diana Capp	Upper Columbia Resources Council	(509) 779-4250
Tim Coleman	Kettle Range Conservation Group	(509) 775-2667
Brett Roberts	Ferry County Action League	(509) 775-3127
Gordon Strandberg	Ferry County Cattleman's Association	(509) 779-4704
Jon Newman	Vaagan Bros. Lumber	(509) 775-3346
Josh Marshall	Boise Cascade	(509) 738-3272
Steve McIntosh	Echo Bay Minerals	(509) 775-3157
Jim Schumacher	Ferry County Natural Resources Board	(509) 779-4039
Dave Robinson	Concerned Friends of Ferry County	(509) 779-4967
Agency Representatives		
Michael Hampton	Colville National Forest, Republic Ranger District	(509) 775-3305
Bert Wasson	Colville National Forest Hydrologist	(509) 684-7213
Karen Honeycutt	Colville National Forest Fisheries Biologist	(509) 684-7224
Allen Palmanteer	WA Dept. of Fish and Wildlife, Area Biologist	(509) 738-2364
Jean Parodi	WA Dept. of Ecology Project Manager	(509) 456-6160
Adeline Fredin	Colville Tribes	(509) 634-2692
Jim Schumacher	Ferry County Natural Resource Board	(509) 779-4039
Brad Duda	Kettle River Advisory Board	(509) 684-5139
Patrice Beckwith	Natural Resources Conservation Service	(509) 775-3473
Mick Lewis	Natural Resources Conservation Service	(509) 685-0937
Bob Gillaspy	Natural Resources Conservation Service	(509) 685-0937
Tom Allen	Natural Resources Conservation Service	(509) 685-0937
Todd Thorn	WA Dept. of Natural Resources	(360) 902-1111
Dr. Mansour Samadpour	University of Washington	(206) 543-5120
Chris Tretter	Ferry Conservation District	(509) 775-3473
Randy Williams	Ferry Conservation District	(509) 775-3473

Data Quality Objectives

Precision and Bias

Factors influencing the precision and accuracy of data collected during this study include proper maintenance and calibration of measuring instruments, following established and recommended procedures for analyzing data, and following established procedures for taking field measurements. Factors influencing bias include sample gathering procedures, and storage and handling of samples. Therefore, the District staff will follow *Standard Operating Procedures for Water Quality Monitoring* adopted from Stevens Conservation District (when applicable), and develop other DOE acceptable procedures for measurement, collection, and storage of samples to optimize precision and reduce bias. Dr. Samadpour will provide QA/QC procedures for the collection and transportation of fecal samples. Linda Sexton, Limnology Lab Manager at Eastern Washington University, will provide QA/QC procedures for the handling and analysis of samples at the Limnology Laboratory (see page 46 for details).

Table 9 provides data quality objectives for field measurement instruments. Standard operating procedures have been developed for each instrument that includes specific information concerning calibration, measurement procedures, general considerations, and maintenance of each specific field or laboratory instrument use by the District (see section on standard operating procedures).

Representativeness and Completeness

Water sampling stations have been designed to represent current land-uses within each watershed. The water sampling schedule captures a time period of fourteen months. This sampling schedule will account for spring runoff through fall low flows, and capture storm events during low water periods. The storm event sampling schedule can be disrupted if no storms occur during the study period.

Stream temperatures will be continuously monitored, on an hourly basis, from June to October. Temperature monitoring locations have been designed to capture factors that have been shown to effect temperatures on other streams within Ferry County. Canopy and riparian surveys will be conducted along the stream reach segments between temperature monitoring stations. Canopy surveys will be conducted in mid-summer to represent total canopy cover. Deciduous trees lose their leaves in the fall, reducing canopy cover on some stream reaches.

Upland watershed and riparian conditions will be inventoried to determine if the biological and physical attributes of each are functioning properly to maintain an extraordinary level of water quality. Factors influencing erosion and riparian buffer functioning will be monitored when snow is absent so that one can see the ground.

Table 9: Field data quality objectives

Parameter	Instrument	Instrument Range; Resolution	Expected Range	Predicted Accuracy	Precision Objective (RSD)	Experienced Precision (RSD)*	Experienced Accuracy *
Dissolved Oxygen	YSI Model 51B	0-15 mg/L; 0.1mg/L	6-14mg/L	(+/-)0.2mg/L	5%	X	X
	Hach sensION156	0-20 mg/L; 0.1 mg/L	6-14mg/L	(+/-) 1% full scale	5%	X	X
pH	Hach sensION156	2.00-19.99; 0.01 pH units				X	X
	Hanna HI931000	0.00-14.00; 0.01 pH units	6.5-8.5 pH units	(+/-)0.01 pH unit	5%	X	X
Conductivity	Hanna HI8633	0-1999; 1µS/cm	200-300 µS/cm	(+/-) 20µS/cm	5%	X	X
	Hach sensION156	0-1999: 0.1µS/cm	200-300 µS/cm	(+/-) 0.5% full range	5%	X	X
Temperature	YSI Model 51B	(-)5 to 45; 0.1 Centigrade	0.0 to 16.0 Centigrade	(+/-) 0.4 degrees	5%	X	X
Velocity	Swoffer Model 2100	0.1 to 25.0; 0.1 ft/s	0.2 to 10.0 ft/s	(+/-) 2%	20%	X	X
Canopy Cover	Spherical Densiometer	0 to 100 %	0 to 100%	5% at >50% Canopy Cover	20%	X	X
Temperature	Optic StowAway Temp Logger	(-)5 to45; 0.01 Centigrade	0.00 to 16.00	(+/-) 0.25 degrees	5%	X	X

* Steps have been taken to determine actual field precision and accuracy

Volunteer monitoring by private landowners and/or permission for District staff to access private land is an essential part of this study. Letters have been drafted and sent to private landowners, and public land managers. Articles will be published in the local paper informing the public of when and where the Kettle Tri-Watershed Management Team (KTWMT) will meet. Approximately half the KTWMT will consist of private landowners. Efforts have been made to provide interested volunteers with up to date information, and training in the areas of water sample collection, and physical environmental measurements.

Comparability

Temperature profiles for each stream, and factors influencing temperature, will be comparable to other streams in Ferry County. In order to insure that data can be transferred between agencies, procedures for collecting and analyzing data are comparable to those established by Stevens Conservation District, Colville National Forest, Natural Resources Conservation Service, and the Department of Ecology. At least three water quality sampling sites correspond with sampling sites previously established and monitored by the Colville National Forest.

Standard Operating Procedures

Collection of Water Samples

CHEMICAL/PHYSICAL

Application: Collecting water samples for laboratory analysis of:

Nitrate-Nitrite Nitrogen	Ammonia Nitrogen
Total Phosphorus	Turbidity

Container: 1-L amber high-density polyethylene bottle
Preservation: NONE
Storage: Cool to 4ºC
Holding time: Chemically sensitive parameters will be analyzed approximately 24 hours after collection.

Collection:

1. Verify that the identification on the sample bottle to be used corresponds to the site being sampled.
2. Remove the cap from the container just prior to sampling collection.
3. Grasp the container at the base, away from the mouth, and quickly submerge the bottle (mouth down) below the surface.
4. Turn the bottle into the flow with the mouth angled slightly upward to allow air to escape and the bottle to fill.
5. If there is no current, create one by moving the bottle forward horizontally (away from your hand).
6. Rinse the container and cap 3 times by repeating steps 2-5.
7. Facing upstream, collect a grab sample in front of your body at mid-stream (or the portion with predominant flow) and at 6/10 depth from the surface.
8. Leave approximately 25 to 50 ml as air space. Replace the bottle cap as soon as possible.

General Considerations:

1. Unless otherwise noted, at least 10% of all chemical/physical water samples will be taken in duplicate to check for precision.
2. The lab contracted with to conduct the chemical and physical analysis will provide documentation of duplicate analysis.

Standard Operating Procedures

Use of Field Instruments

Dissolved Oxygen

Application:	Measuring dissolved oxygen concentrations in fresh or salt water.
Instruments:	YSI Model 51B
Equipment:	YSI 5718 Field Probe
Range:	0-15 mg/L
Resolution:	Better than ±0.1 mg/L
Accuracy:	±0.2 mg/L
Reagents:	KCI- probe solution

Set up and Calibration (Calibration to 100% air saturation)

1. With meter off, adjust meter mechanical zero if necessary using the regular screw directly underneath meter face.
2. Switch the function knob to “ZERO” and adjust to “0” on the mg/L scale.
3. Switch to “FULL SCALE” and adjust to 15 on the mg/L scale. Switch the function knob to “READ TEMP AND SET DIAL” position.
4. Place probe in calibration bottle with sponge wetted. Wait at least 10 min. for temperature to equilibrate.
5. After 10 minutes, set 0_2 SOLUBILTY factor dial to correct temperature using the fresh water scale.
6. Turn function knob to “CALIB 0_2” position and using the altitude on the short scale in upper right hand corner of meter face. Wait for meter to show a stable reading for 1 min.

Measurements:

1. Calibrate instrument as described in steps 1-6 above.
2. Remove probe from calibration bottle and submerge in water to be tested. Set the function switch to “READ TEMP AND SET DIAL” Wait at least 1 full minute for temperature to equilibrate (meter will show stable reading).
3. Set 0_2 SOLUBILITY factor DIAL to sample temperature for fresh water.
4. Switch to READ 0_2 and read mg/L dissolved oxygen.
5. Record value, remove probe from water and place it back in the calibration bottle.

Quality Control:

1. The meter is recalibrated using the appropriate elevation at each sampling site if necessary.
2. At least 20 % of DO measurements are taken in duplicate.
3. A record of precision and comparison of the two records is maintained and quarterly update in Microsoft Excel format.

General Consideration:

1. The instrument is not to be turned off between sampling sites; it is to be left on until all measurements have been taken for the day.
2. The instrument is often recalibrated before duplicate measurements are taken.
3. Values are reported to the nearest 0.1 mg/L.

Maintenance:

1. The probe is stored in the calibration chamber where the sponge is to be kept moist.
2. The cable, probe, and membrane are inspected regularly and recorded in the instrument maintenance schedule.
3. The probe membrane and KCL solution are changed once every 2 months depending on instrument use.

Standard operating procedures

Use of Field Instruments

SPECIFIC CONDUCTANCE

Application:	Measuring the specific conductance of fresh water
Instruments:	HANNA # I-8633
Equipment:	Conductivity probe beaker
Range:	0 to 1999 µS/cm
Resolution:	1 µS/cm
Accuracy:	± 20 µS/cm
Regents:	Reference solution (120 µS/cm @ 25*C) distilled water

Calibration:

1. Rinse probe with distilled water.
2. Push the key "COND/TEMP" to display the ºC symbol. Measure the temperature of the calibration solution and adjust the temperature knob until the same temperature appears in the display. Press the "COND/TEMP" key again to make sure the screen clears.
3. Fill provided container with fresh conductivity reference solution and immerse probe to at least ½ inch above upper air vent.
4. Tap probe to get rid of air bubble trapped under sleeve.
5. Turn the instrument on and select 199.9 µs range. Wait 5 min. for the probe to reach thermal equilibrium.
6. Use a screwdriver to turn the timer until display reads 120 µs/cm.
7. Remove probe and rinse with distilled water.

Measurements:

1. Turn instrument on.
2. Set temperature for stream temp.
3. Immerse the probe in water to be measured and select the measurement range by pressing one of the range keys.
4. Gently tap probe to make sure no air bubbles remain trapped in probe.
5. Allow time for reading to stabilize and record. Hold probe off bottom while recording conductivity.

Quality Control:

1. A check standard near the range of measurement will be analyzed the day of sampling to provide an estimate of accuracy.
2. If the check standard is not within expected accuracy (20µs/cm), the instrument needs to be calibrated.
3. At least 20% of the measurements are taken in duplicate.
4. A record of precision and accuracy is maintained and updated quarterly in Microsoft Excel format.

General Consideration:

1. The conductivity probe must be allowed to reach thermal equilibrium because significant errors can result from inaccurate temperatures.
2. It may be necessary to soak conductivity probe in distilled water for about 10 min. before the first measurements of the day.

Maintenance:

1. The probe is rinsed with distilled water and dried before storage.
2. The cable and probe are inspected regularly and a record of maintenance activity is kept on the instrument maintenance schedule.
3. As part of the regular maintenance schedule, the PVC sleeve is removed and the electrode is cleaned with a cloth or a non-abrasive detergent.

Standard Operating Procedures

Use of Field instruments

Canopy Density

Application:	Measuring canopy densities of stream reach segments.
Instruments:	Spherical Densiometer Model A
Range:	1-100 %
Resolution:	5% canopy cover
Accuracy:	5% at >50% canopy center

Calibration:

NONE

Measurements:

1. Proceeding downstream, stop at 100’ intervals to take canopy measurements. Four measurements will be taken at each station to develop an average canopy cover percentage.
2. The first measurement will be taken standing in the middle of the stream facing downstream.
3. Hold the instrument at elbow height and count the number of squares in which you can see open sky.
4. Multiply the number of OPEN squares by 4 (24 squares x 4 =96 total) and record this number.
5. Repeat steps 3 and 4 standing in the middle of the stream looking at the right bank, then upstream, and finish with left bank.
6. Develop an average canopy cover for each station by averaging the four readings.

Quality Control:

1. At least 20% of the measurements for a reach are taken in duplicate.
2. A different individual will duplicate 10% of the entire number of reaches on each stream.
3. A record of precision will be kept and updated quarterly using Microsoft Excel format.

General Consideration:

1. A slight discrepancy exists between the total number of squares on the Densiometer (24x4=96) and 100%. This will be corrected by multiplying the average canopy cover (%) for each station by 1.04.
2. Left-bank and right-bank are determined while looking downstream.

Standard Operating Procedures

USE OF FIELD INSTRUMENTS:

pH

Application:	Measuring the pH of fresh water.
Instruments:	Barnant Digital pH meter
Range:	0 to 14 pH units
Resolution:	0.01 pH units
Accuracy:	± 0.01 pH units
Equipment:	Sealed pH electrode, Temperature probe, 2 Buffer Solution Bottles, 1L Polyethylene bottle.
Reagents:	7.00 pH buffer solution 9.18 pH buffer solution

Calibration:

1. Make sure the 7.0 and 9.18 pH buffer solution bottles are filled to line.
2. Rinse pH probe with distilled water and blot dry with lint-free cloth or napkin.
3. Immerse pH probe in 7.0 pH buffer solution. Record temperature (ºC) of pH buffer, and set temp knob to match.
4. Allow a brief time for pH probe to equilibrate with temperature of buffer solution.
5. Adjust slope control fully counter clockwise.
6. Turn the unit on and adjust the standardize knob to read 7.0.
7. Remove probe, rinse with distilled water, and dry.
8. Immerse pH probe in 9.18 pH buffer.
9. Turn instrument on and adjust slope control screw to cause display to indicate pH of second solution.
10. Remove probe and rinse with distilled water.

Measurements:

1. Following standard operating procedures for collecting water samples, fill a polyethylene bottle with a water sample.
2. To maintain sample temperature, keep the sample bottle in water.
3. Submerge about 1 inch of electrode and temperature probe in sample. Stir probe briefly and allow about 3 minutes for probe to equilibrate with temperature.
4. Set temperature dial on instrument to match sample.
5. Turn unit on and record pH.
6. After recording pH, remove probes and rinse them in distilled water.
7. Place electrodes in soaker bottle containing 4.01 Buffer solution.

Quality Control:

1. Calibration procedure is performed the morning of "Sampling Day".
2. The 7.00 buffer solution is analyzed once after calibration and once during sampling day to provide an estimate of accuracy.
3. The meter is recalibrated if pH is not within 0.1 pH units of the neutral buffer solution.
4. At least 20% of the pH measurements are taken in duplicate.
5. A measurement of precision and accuracy is maintained and updated quarterly in Microsoft Excel format.

General Considerations:

1. The temperature difference between buffer solution and samples should be less than 2ºC, but this is often impractical for field measurements. To approximate water temperatures, Buffers are kept cool before use if necessary.
2. Results are recorded to the nearest 0.01 pH unit but reported to the nearest 0.1 pH unit.

Maintenance:

1. The pH electrode is rinsed with distilled water and placed in 7.01pH or storage solution. The cables, connections, and electrode are inspected regularly and a record of maintenance is maintained and updated quarterly in Microsoft Excel format.

Standard Operating Procedures

Use of Field Instruments

Velocity

Application:	Measuring the velocity of flowing water
Instruments:	Swoffer Model 2100
Equipment:	Current meter and sensor, Top setting wading rod
Range:	0.1 to 25 ft/s
Resolution:	0.01 ft/s
Accuracy:	± 2% at 0.05 ft/s

Calibration

1. Determine a calibration number for the current meter when working with slow flows (<1.5 ft/s). Otherwise, the calibration number should be between 180-186 when instrument is set to read ft/s with a 2inch propeller.
2. Rotate selector switch to CALIBRATE position.
3. The readout should be between 180-186. If it is not within this range, replace battery and check again.

Measurement:

1. Fasten tape measure across stream from bank to bank just above water level and perpendicular to flow.
2. Attach sensor to wading rod.
3. Determine the number and length of intervals needed to define the channels bed contour (no more than 5% of the flow is in any one interval).
4. Select an averaging period of velocity using the selector switch on the current meter. (Usually use MAX setting).
5. Using the depth gauge on the wading rod, set the sensor depth at 6/10-stream depth with the propeller facing into stream flow.
6. Press and release the RESET button to zero display.
7. The next figure that appears on the display will be velocity for that stream interval.
8. Repeat steps 4-7 until all intervals are measured. Be sure to record distance from stream bank, depth, and velocity at each measurement point.

Quality Control:

1. At least 20% of the velocity measurements taken in a given stream cross section will be taken in duplicate.
2. The velocity profile will be measured twice for at least 10% of the streams measured in a sampling day.
3. The calibration number should be checked periodically while in the field, and a spare battery will be kept with the unit at all times.
4. A record of precision for velocity measurement and flow calculations will be kept in Microsoft Excel format and updated quarterly.

General Considerations:

1. Right and left banks are defined while looking downstream.
2. Velocity measurements are recorded to the nearest 0.01 ft/s and flow calculations recorded to the nearest 0.1 ft/s.
3. Keep the sensor/propeller above streambed when taking measurements to prevent sand and silt from entering bearing surfaces. Water is the only bearing lubricant.

Maintenance:

1. Probe, rod and meter are dried before storage.
2. The cable, connections and propeller units are inspected regularly and a record of maintenance activity is kept in the instrument maintenance schedule.

Standard Operating Procedures

Collection of Water Samples

Fecal Coliform

Application:	Collecting water samples for enumeration of fecal coliform bacteria
Container:	Sterilized 500 mL polypropylene bottle
Preservative:	None
Storage:	Cool to 4 °C
Holding Time:	Samples will be analyzed same day as collected.

Collection:

1. Verify that the identification on the sample bottle to be used corresponds to the site being sampled.
2. Only use sterilized bottles.
3. Remove cap from bottle just before sample collection.
4. Facing upstream, grasp the container at the base, away from the mouth, and quickly submerge the bottle (mouth down) below the surface.
5. Turn the bottle into the flow with the mouth angled slightly upward to allow air to escape and the bottle to fill.
6. If there is no current, create one by moving the bottle forward horizontally away from your hand.
7. Collect a grab sample in front of your body at mid-stream (or the portion with predominant flow), and at 6/10 depth from the surface.
8. Leave approximately 25 to 50 ml of the container volume as air space. Replace the bottle cap as soon as possible.

General Considerations:

1. DO NOT rinse the sample bottle before collection.
2. DO NOT contaminate the lid or inside of the bottle with your fingers, dirt, dust, or anything else.
3. DO NOT pour water into fecal coliform bottle from another container.
4. Air space is required to allow proper mixing before analysis.
5. Bacteria generally concentrate at the water surface, and this layer should be avoided by plunging the bottle with the mouth facing down.
6. Fecal coliform samples tend to vary quite a bit. Therefore, at least 3 fecal coliform samples will be collected at each sample during each sampling event. This will provide the laboratory analyzing the samples to run duplicates and keep a record of precision.

Standard Operating Procedures

Selection of Sampling Sites

SAMPLE COLLECTION

Application: Selecting sites suitable for collection of water samples.

General Considerations:

1. The guidelines given below will be followed whenever possible. However due to variability in flow and other site-specific conditions, Conservation District staff must use their best judgment when locating sampling sites. If these guidelines cannot be met, non-standard procedures and circumstances will be noted in the field book and kept in a record on non-standard procedures.

Guidelines:

1. Sites should be deep enough to allow a sample bottle to be submerged without disturbing the bottom sediments. If bottom sediments are disturbed, another location will be chosen. However, if no other suitable location can be found, the site should be allowed to flush completely before samples are collected.
2. Stream samples should be collected from the portion of the channel with predominant flow. Samples will not be taken from backwater pools of standing water where relatively long detention times allow the water to stagnate.
3. The outfall from culverts should not be sampled when collecting bacteriological samples. Bacteria generally concentrate at the top microlayer of the water surface, which may be difficult to avoid.
4. If sampling downstream of a tributary, sites should be located far enough downstream to allow complete mixing of the two waters (i.e. avoid mixing zones).

- The order of magnitude of the distance from a point source to the zone of complete mixing can be calculated using:

$$L=2.6V(W^2/D)$$

Where:

L= distance from source to well mixed zone (ft)
V= average stream velocity (feet per second)
W= average stream width
D= average stream depth (ft)

Standard Operating Procedures

<u>Selection of Sampling Sites</u>

Velocity Measurement

Application: Selecting sites suitable for velocity measurements and flow calculations

General Considerations:

1. The guidelines given below will be followed whenever possible, but seldom will all the criteria be met at a given site. If conditions are considerably different than those described below, they will be noted in the field book and kept in a record of non-standard procedures.
2. Routine and/or duplicate flow measurements will be made within the same stream reach, but they may not necessarily be taken from the same cross section.

Guidelines:

1. The stream reach should be straight for approximately 300 feet upstream and downstream of the site.
2. Surface and/or subsurface flow should not be bypassing the site (i.e. the flow is confined to one channel).
3. A cross section should be located far enough upstream of tributaries that they do not influence flow regimes in the stream being monitored.
4. Areas downstream of rapid changes in stream gradient and velocity should be avoided.
5. The cross section used for measurements should be located in an area with:
    - Parallel stream banks
    - Relatively few larger rocks
    - Few or small irregularities on the bottom
    - A relatively uniform stream bed
    - No eddies, slack water, or excessive turbulence, and
    - Little or no vegetation.

Standard Operating Procedures

<u>Use of Laboratory Instruments</u>

Turbidity

Application:	Measuring the Turbidity of fresh water
Instruments:	LaMotte Model 2008
Equipment:	0.5 NTU and 5.0 NTU turbidity standards, set of 6 turbidity tubes, syringe & filter holder, membrane filters, 0.45 micron.
Range:	0-19.99 NTU 0-199.9 NTU
Resolution:	0.01 NTU
Accuracy:	$\pm$ 2%

<u>Calibration:</u>

1. Select a Turbidity standard solution closest to the value of the sample.
2. Switch selection knob to proper range (0-20 or 0-200 NTU)
3. Fill Turbidity tube with standard, wipe tube with a lint-free tissue and place into chamber, cap chamber.
4. Adjust STANDARDIZE knob until display reads value of standard.

<u>Measurements:</u>

1. Collect field sample, (see standard operating procedures for the collection of water samples).
2. Rinse a Turbidity tube with sample. Fill tube to neck with sample water.
3. Cap with paired, marked cap, and wipe tube with lint-free tissue.
4. Insert tube into chamber and cap chamber. Select appropriate range on selection knob (typically 20NTU).
5. Record NTU when reading stabilizes.

<u>Quality Control:</u>

1. Calibrator procedures will be performed the day measurements are to be taken.
2. At least 20% of the Turbidity measurements will be taken in duplicate.
3. A 5.0 NTU or 0.5 NTU, and a 20.0 NTU turbidity standard will be analyzed once after calibration and once during each analysis day to provide an estimate of accuracy.
4. A measurement of precision and accuracy is maintained and updated quarterly in Microsoft Excel format.

<u>General Considerations:</u>

1. Turbidity tubes are paired with caps. Each cap is marked with a piece of tape. Tubes should be inserted into chamber with tape oriented in the same direction every time.

Maintenance:

1. If there is no display when the unit is turned on, the battery has no charge. Plug in the adapter with selector knob turned off and leave overnight.
2. Analyzing an empty cell in the chamber inspects the lamp. If the display is unstable, the lamp needs to be replaced.
3. Monitor battery function and be aware that rechargeable batteries can wear down and fail.

Standard Operating Procedures

Monitoring Water Temperature
Hourly Monitoring Device

Application:	Long-term, continuous temperature monitoring
Instrument:	Optic StowAway Temp.
Equipment:	Optic Base Station
Range:	-5 to 45°C
Accuracy:	± .25°C
Resolution:	.01°C

Setup and Calibration

1. Prepare coffee cup or jar with a mixture of crushed ice and water.
2. Place Optic StowAway in the ice/water mixture in refrigerator to reduce temperature gradient.
3. Leave the Optic StowAway unit and crushed ice mixture in the refrigerator for approximately 20 minutes.
4. Plug Optic Base Station into serial port on back of computer, and start Boxcar Pro version 3.5 or better.
5. Remove Optic StowAway from the ice mixture and couple with the base station.
6. From the menu bar, chose *offload data from logger* and follow the instructions.
7. Recorded temperatures should be above 0.00°C, but below 0.1°C. If not, check settings and repeat steps 1-7. If problems persist, the logger is not functioning properly.

Measurements:

1. Check temperature logger to make sure it is functioning using the above procedure.
2. Set delayed start for date and time for logger to begin recording temperatures at 1 hour intervals.
3. Temperature loggers to be left in-stream should be encased in 1 1/2 to 2 inch diameter PVC pipe with one end permanently closed and the other accessible by screw cap.
4. Place the PVC enclosed temperature logger in a stream location deep enough for the unit to remain submerged throughout the monitoring season.
5. Remove logger from stream and download data at the end of monitoring season.

Quality Control

1. On water sampling days, stream temperature will be manually recorded using a stream thermometer or other measuring device.
2. This data will be compared to the Optic StowAway readings, and a record of accuracy will be kept for 10% of the StowAway units in the field at any given time.
3. Accuracy records will be kept in Microsoft Excel format.

Maintenance:

1. Battery charge will be checked before the StowAway Temp monitoring units are placed in the field.
2. Algae will be cleaned off external surfaces of the units, taking care not to scratch the unit, before downloading data.
3. Cables and connectors associated with the Base Station will be inspected regularly.

Standard Operating Procedures

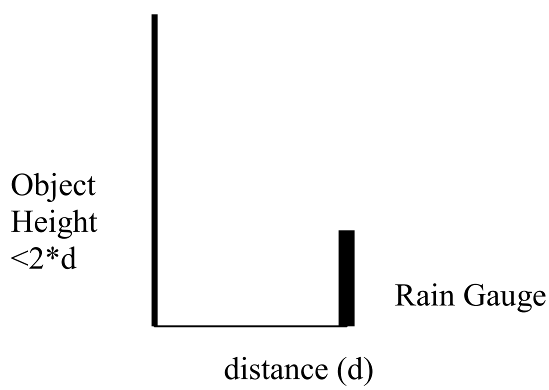
Use of field instruments

Measurement of precipitation

Application:	Monitoring precipitation
Instrument:	Novalynx Forestry Rain Gauge
Equipment:	Measuring stick, measuring tube, and support bracket
Range:	0 to 7 inches
Resolution:	0.01 inch
Accuracy:	---
Reagents:	None

Setup and Site Selection

1. The best site to place the rain gauge is in an area with full or partial blockage of wind, yet clear of surrounding objects. The rule to follow when choosing a site is that objects surrounding the gauge must be less than twice as tall as the distance of the object from the gauge.



2. Once an appropriate site has been selected, mount the rain gauge and bracket on a fence post or pole.
3. Use a carpenters level to plumb the rain gauge.
4. Remove the measuring stick from the rain gauge and store it in a place near the gauge if possible.

Measurement:

1. Before the onset of a storm, visit the rain gauge to make sure the collection tube is free of dirt, leaves, insects, etc.
2. After a storm, visit the rain gauge. Allow any water on the funnel to drip into the collection tube.

3. Gently tap the collection tube to allow drops on the inside edges of the tube to drop into the collected water.
4. Lower the measuring stick into the collection tube until it just comes in contact with the bottom of the collection tube.
5. Lift the stick out and read and record the water mark.
6. Empty the water out of the collection tube. Shake the tube to remove any excess water and place it back into the gauge.

General Considerations

1. In a severe rain event, the collection tube may completely fill and begin to overflow. In this case, the rain gauge canister will collect the overflow. The water in the collection tube will need to be measured and emptied. Then, the water collected as overflow in the canister will need to be carefully poured into the measuring tube and measured.
2. Winter precipitation in the form of snow or sleet can be collected as well by removing the funnel and collection tube to allow precipitation to collect in the larger collection canister. The frozen precipitation collected in the canister will then need to be melted and poured into the collection tube to be measured with the measuring stick.

Maintenance

1. Site visits should be scheduled after every storm event to measure and record precipitation. During this time, any debris collected during the storm must be removed.
2. A visual inspection of the gauge and its support structure will reveal if the gauge should be re-plumbed.
3. Always take clean water to rinse dirt, mud, leaves, insects and other debris out of the collection tube and funnel.

Standard Operating Procedures

Use of field instruments

Dissolved Oxygen

Application:	Measuring dissolved oxygen concentration of fresh water.
Instruments:	Hach sensION156 multi-parameter meter.
Equipment:	Hach dissolved oxygen probe.
Range:	0-20 mg/L
Resolution:	0.01 mg/L
Accuracy:	± 1.0% full scale
Reagents:	KCl – probe solution

Setup

1. To access the dissolved oxygen setup menu, turn the meter on and press the **DO** key.
2. Press **setup** key.
3. Use the up **arrow** key to scroll to setup menu option #5 (options 1-4 have already been set). Use the **enter** button to toggle the display lock to the on position.
4. Remaining in the DO setup menu, use the up **arrow** key to bring up setup option #6, and set resolution at 0.00 mg/L.
5. Use the up **arrow** key to bring up DO setup option #7, and set salinity correction factor to 0 for fresh water.
6. Press the **exit** button to return the meter to read mode.

Calibration (Calibrate in water saturated air)

1. Prepare the calibration/storage chamber by placing a damp sponge in the lower chamber.
2. Insert the DO probe in the calibration and storage chamber. The tip of the probe must not be flooded with water or holding a drop of water on the membrane.
3. Allow at least 10 min. for the atmosphere in the chamber to reach a steady state.
4. Press the **DO** key to place the meter in DO read mode.
5. Press the **cal** key.
6. The display will show 100%. Press the **enter** key. The **stabilizing** icon will appear while the meter completes the calibration.
7. When calibration is complete, the meter will return to the reading mode – ready to take samples.

Measurement

1. Insert the probe to about 6/10 stream depth. The probe must be deep enough to cover the thermistor (metallic button) located on the side of the probe.
2. Agitate the probe in the sample to dislodge any air bubbles from the probe membrane.
3. Make sure there is sufficient flow across the probe tip.

4. The meter will beep 3 times when the meter stabilizes. Record the value for dissolved oxygen (mg/L) on the field data sheet.

Quality Control

1. The meter should be recalibrated with every 500’ change in elevation.
2. At least 20% of the DO measurements will be taken in duplicate.
3. A record of precision is maintained and updated quarterly in Microsoft Excel format.

General Considerations

1. Store the probe in the storage/calibration chamber between measurements.
2. Connect probe to meter and allow 5 –25 minutes for probe to polarize with meter before calibrating.
3. If DO probe has been disconnected, allow 5 – 25 minutes for DO probe to re-polarize with meter before taking another DO reading.

Maintenance

1. The membrane cap should be inspected for damage during sampling and at the end of each sampling day. If membrane appears to be damaged, it should be replaced.
2. Electrolyte filling solution should be replaced at regular intervals of 2 months.
3. Prior to replacing membrane cap and electrolyte solution, rub the anode with supplied polishing cloth.

Standard Operating Procedures

<u>Use of field instruments</u>

pH

Application: Measuring the pH of fresh water.
Instrument: Hach sensION156 multi-parameter meter.
Equipment: Hach platinum series electrode, 2 buffer solution bottles, 1 L polyethylene bottle.
Range: 0 – 14 pH units
Resolution: 0.01 pH units
Reagents: 7.00, and 4.01 pH buffer solutions.

Setup

1. To access the pH setup menu, turn on the meter and press the **pH** key.
2. Press the **setup** key.
3. Use the up **arrow** key to scroll up to setup option #5 (options 1-4 have already been set). Use the **enter** button to toggle display lock to the on position.
4. Remaining in the setup menu, use the up **arrow** key to bring up setup menu option #6. Set resolution to 0.00.
5. Remaining in setup menu, use up **arrow** key to bring up setup menu option #7. Set auto buffer recognition to 7.00.
6. Press **exit** to return to read mode.

Calibration

1. Prepare 2 buffer solutions (7.00 and 4.01).
2. Turn instrument on. From the pH reading mode, press **cal** and a flashing **?** will appear in the upper display area along with **standard** and **1**.
3. Place the pH electrode in one of the buffers.
4. Press the **read** button. The instrument will automatically recognize the calibration buffer value. The temperature and pH values will be updated until a stable reading is reached.
5. When reading has stabilized, the **standard** # will change to **2**.
6. Remove probe from first buffer and rinse with deionized water before placing in second buffer.
7. Press **read**. The temperature and pH value will be updated for the second buffer when a stable reading is reached.
8. Press **exit** then **enter** to accept the calibration. The instrument will state a slope value at this point. Record the slope value.

Measurement

1. Following standard operating procedures for collecting water samples, fill a 1 L polyethylene bottle with water sample.

2. To maintain sample temperature, keep sample bottle in water.
3. Turn meter and press the **pH** button.
4. Place pH electrode in sample and press the **read** button. **Stabilizing** will appear in the display along with sample temperature and pH value.
5. The instrument will beep 3 times when the reading has stabilized.
6. Record pH value and water temperature.
7. Remove the electrode from sample and rinse with deionized water before taking the next sample.

Quality Control

1. Calibration procedure is performed the morning of sampling day.
2. The 7.00 buffer solution is analyzed once after calibration and once during sampling day to provide an estimate of accuracy.
3. The meter is recalibrated if pH is not within 0.1 pH units of the neutral buffer.
4. A measurement of precision and accuracy will be kept and updated quarterly in Microsoft Excel format.
5. At least 20% of all pH readings will be taken in duplicate to calculate precision.

General Considerations

1. Temperature differences between buffer and sample should be less than 2 °C, but this is often impractical for field measurements. To approximate water temperatures, buffers are kept cool before use.
2. Results are recorded to the nearest 0.01 pH units but reported to the nearest 0.1 pH unit.

Maintenance

The pH electrode is rinsed with deionized water and placed in storage solution for storing. A record of maintenance will be kept and updated quarterly in Microsoft Excel format.

Standard Operating Procedures

Use of field instruments

Specific Conductance

Application:	Measuring the specific conductance of fresh water.
Instruments:	Hach sensION156 multi-parameter meter.
Equipment:	SenION conductivity electrode.
Range:	0-1999 µS/cm
Resolution:	0.1 µS/cm
Accuracy:	± 0.5% of range
Reagents:	1000 µS/cm

Setup

1. To access the conductivity menu, turn the meter on and press the **con** button.
2. Press **enter**.
3. Press the **setup** button and use the up **arrow** key to scroll to setup option #5 – set the display lock to the **on** position.
4. Remaining in setup menu, use up **arrow** key to bring up setup option #6 – make sure temperature correction factor is set to NaCl.
5. Remaining in the setup menu, use up **arrow** key to bring up setup option #9 – set the reference temperature to 20 or 25 °C. This will be indicated on the reference bottle.
6. Remaining in the setup menu, use the up **arrow** key to bring up setup option #10 – set temperature correction factor **on**.
7. Press **exit** button to return to read mode.

Calibration

1. Turn meter on and press the **con** button and then press **enter**.
2. Make sure the reference temperature in setup #5 above matches the reference temperature of the standard.
3. Place probe in standard solution and agitate probe to dislodge any air bubbles in the electrode cell. Avoid resting the probe on the side or bottom of container.
4. Press **cal**.
5. Press **enter** to calibrate on the standard.
6. The meter will return to the read mode when calibration is finished.

Measurement

1. Turn meter on and press the **con** key and **enter**.
2. Immerse probe in water and gently tap to make sure no air bubbles remain trapped in the probe.
3. When the reading has stabilized, the meter will beep 3 times. Record reading.

Quality Control

1. A check standard near the range of measurement will be analyzed the day of sampling to provide an estimate of accuracy.
2. If the check standard is not within expected accuracy (± 20 µS/cm), the instrument needs to be recalibrated.
3. At least 20% are taken in duplicate.
4. A record of precision and accuracy is kept and updated quarterly in Microsoft Excel format.

General Considerations

1. The conductivity probe must be allowed time to reach thermal equilibrium because significant errors can result from inaccurate temperatures.
2. It may be necessary to soak conductivity probe in deionized water for about 10 min. before the first measurements of the day.

Maintenance

1. The probe is rinsed with distilled water and dried before storage.
2. The cable and probe are inspected regularly and a record of maintenance activity is kept and updated quarterly in Microsoft Excel format.

Analytical Procedures

See standard operating procedures for the analytical procedures to be followed for measuring pH, dissolved oxygen, turbidity, temperature, conductivity, flow, canopy cover, and collecting water samples. Fecal coliform colonies will be analyzed using a membrane filtration method approved by the Environmental Protection Agency. Eastern Washington University's limnology laboratory, certified by the DOE, will perform the fecal coliform analysis dealing with the number of colonies/100 ml.

Riparian and Upland Survey Methodology

To begin the riparian survey, the stream will be segmented by Rosgen channel type. The functioning condition of riparian areas will be determined using procedures established by the Bureau of Land Management, and described for each Rosgen channel type segment (or reach). According to this survey methodology, riparian areas are functioning properly when adequate vegetation, landform, or large woody debris is present to:

1) dissipate stream energy associated with high water flows, thereby reducing erosion and improving water quality;
2) filter sediment, capture bedload, and aid floodplain development;
3) improve flood-water retention and ground-water recharge;
4) develop root masses that stabilize stream banks against cutting action;
5) and support greater biodiversity.

To assess the functionality of a riparian area, it is essential for staff and volunteers to understand the physical and biological attributes of a functioning riparian system. Therefore, one must be able to describe the hydrogeomorphic, vegetative, erosional/depositional, soils, and water quality of the system. These attributes will be described and recorded using the standard checklist in appendix C. In addition to the standard checklist, District staff and volunteers will be recording areas where livestock are concentrated along the stream, the amount of hoof sheer per given reach, and, in general comments, any other observations that might lend insight to condition of watershed health.

The most common problem with upland areas of a watershed affecting water quality is erosion. Erosion, by management or natural causes, can increase turbidity, the amount of dissolved solids (conductivity), the nutrient load, and fine sediments being deposited in-stream. Erosion and direct sedimentation into streams can come from many different sources. Common erosion factors include(USDA Forest Service, 1996):

- Road cutbank/fill slope failure
- Livestock grazing
- Landslides
- Road encroachment and/or channel constriction due to inadequate buffer between stream and road fill
- Lateral bank erosion and/or undercutting
- Culvert failure

- Mining

Forms for completing upland surveys are found in appendix C. As information is gathered, further analysis of upland, riparian, range, and/or water quality parameters may be called for. In this case, standard procedures will be provided to the project manager to review and authorize.

<u>Standard Calculations</u>

A record of precision will be kept and stated as relative standard deviation (RSD). Standard deviation will be calculated using the following formula:

$$Stdv = \sqrt{((\Sigma x_i^2-(\Sigma x_i)^2/n)/n-1)}$$

Where x_i is the ith result in a set of n results, and n is the sample size.

A record of accuracy will be kept along with precision for all instruments when applicable. Accuracy will be calculated by recording the difference between actual and measured quantities. For example, a check standard of known pH will be taken in the field to check the accuracy of the pH meter. If the check standard is a known 7.01 pH units and the instrument reads 7.05, the difference between actual amount and measured amount is .04 pH units. Accuracy will be reported by percentage as follows:

$$\% \text{ Accuracy} = ((\text{actual value} - \text{measured value})/\text{actual value})*100$$

A 95% confidence interval may be calculated for certain variables as a means of comparison. For example, the District will want to know what stream reaches differ significantly according to August high temperatures. Because two or more stream reaches differ in temperature, the difference is not statistically significant unless the two confidence intervals do not overlap. The 95% confidence interval will be calculated using the following formula:

$$CI = \text{average} \pm \alpha(\delta/\sqrt{n})$$

Where:

Average = sample average
α = 1.96 for 95% confidence interval
δ = sample standard deviation (see formula above)
n = sample size

Measures of central tendency will be used to describe certain samples. These measurements include sample average and median. The following formulas will be used when calculating average and median:

$$\text{Average} = \Sigma x/n$$

Where:

x = sample value
n = number of samples
Σ = summation

Sample median is determined by ordering *n* observations from smallest to largest. Then:

Sample median =
- The single middle value if *n* is odd
- The average of the two middle values if *n* is even

Geometric mean = $\sqrt[n]{(x1)(x2)\ldots(xn)}$

Where:
n = the number of samples
$x1$ = the value of sample 1
$x2$ = the value of sample 2
xn = the value of the nth sample

Data Reduction, Review and Reporting

Laboratory results will be presented by sampling site for each water quality parameter measured. EWU's laboratory will review the results of each sampling period for completeness, precision and bias. The laboratory will be asked to provide the results of each sample period in Microsoft Excel format both in a hard copy and an electronic form.

Field measured water quality parameters will be presented by sampling site and watershed. District staff will review the results of each sampling period for completeness and errors. A record of precision and accuracy of field equipment will be kept in Microsoft Excel format in both hard copy and electronic form. District staff will continuously review standard operating procedures to insure compliance throughout the monitoring season. Volunteers will be trained by applying the standard operating procedures through hands-on experience.

Very large data files, such as temperatures monitored throughout the study, will be kept in Microsoft Access format. Summary statistics can be easily calculated and transferred to other Office 2000 programs for reporting using this format. The final report will be summarized by watershed, stream reach, and water sampling station. Final and quarterly reports will be presented in Microsoft Word format. Data summaries used in public demonstrations may be reported in Microsoft PowerPoint format.

Quality Control Procedures

Field Quality Control Procedures

Specific quality control procedures for field measurements are given in the section on standard operating procedures. A record of precision and accuracy will be kept and reported for each field instrument. Volunteers will be trained to follow field standard operating procedures, and accompanied by District staff when gathering water samples, and conducting riparian and upland surveys. After being trained, Volunteers may independently monitor rain gauges, and make not of any conditions related to water quality in their watersheds. Field water samples will be chilled and delivered to Eastern Washington Universities Limnology Laboratory for analysis on the same day of collection.

Laboratory Quality Control

Standard laboratory quality control procedures will be provided for the District from EWU's lab. These procedures will include, but not be limited to, samples being analyzed in duplicate, use of laboratory spikes to indicate bias that may be caused by interference from the sample matrix, and use of external standard solutions. External laboratories used during this project have been certified by the DOE and will provide a copy of their quality assurance plans to the District. At least 10% of all samples will be taken in duplicate, and records of precision and accuracy will be kept.

The following QA/QC procedures have been provided by Dr. Samadpour's laboratory for the DNA source tracking portion of the project.

A. Sampling

Water samples

Water samples will be collected as described in the Standard Methods for the Examination of water and wastewater (APHA, 1997), and delivered (on ice) to a certified environmental microbiology laboratory for analysis within eight hours of collection. All the sample bottles will be labeled with sampling station identification number, sampling date and time, sample number, source identification number, and sampler's initials. All the sample information will be entered into the field log, and chain of custody forms. The chain of custody form will be signed by the sampler and the receiving laboratory.

Water samples will be analyzed by the mFC method (Standard Methods for Examination of Water and Wastewater, ASPH, 1997). To ensure aseptic conditions, blank samples will be filtered to determine whether our filtering apparatus, dilution blanks, and other equipment are free of contamination by fecal coliforms. Prior to filtering each sample, a blank sample (containing only dilution water) will be filtered. This will allow testing of the sterility of our filter tower and dilution water. Following the filtering of the prescribed number of dilutions, a final blank will be filtered. This will allow us to determine whether our rinsing method between individual dilutions was adequate enough to prevent contamination from previous samples. After incubation the results will be entered into result forms, and the forms will be sent to the Soil Conservation Office for entry into a database. All Fecal coliform plates from every sampling event and every sample station will be boxed and shipped overnight to Dr. Samadpour's Laboratory (206) 543-5120 at the Health Science Building room E. 164, University of Washington, Seattle, WA 98195 for ribosomal RNA typing.

Source samples

Fresh animal fecal samples will be collected aseptically into sterile containers and shipped to Dr. Samadpour's lab by overnight mail, on ice. Animal fecal samples are only collected when they are positively identified as belonging to a given animal species. No more than three samples will be collected from the members of the same animal species from a given location. Only a single sample will be collected from an individual animal. All sample containers will be labeled with the following information: Sample type, host species, sample date and time, sample location, and sampler's initials. All the sample information will be logged into the field log. Fecal samples will be taken from each watershed and the surrounding area (northern Ferry County). After collection of the samples, samples are delivered to the DSCD's office where they will be given a sample number and will be logged into the permanent sample log. The samples will be kept refrigerated, and are shipped to Dr. Samadpour's laboratory using overnight mail. Samples are not to be stored for more than 4 days prior to shipping.

B. Microbial Source Tracking

The goal of the MST project is to identify the sources of fecal coliforms which are present in water samples. Two types of samples will be received from the USGS laboratory: water and fecal samples. Our laboratory analysis includes

1. Sample arrival, and logging.
2. Isolation and purification of E. coli strains from water and fecal samples.
3. Growing pure cultures of E. coli strains for freezing (long term storage), and isolation of DNA.
4. Restriction enzyme digestion and Agarose gel electrophoresis of DNA samples.
5. Southern blot hybridization using radio labeled cDNA probe for rRNA genes.
6. Exposure of Autoradiograms.
7. Analysis of the data.

1. Sample arrival and logging

All samples, upon arrival are inspected for damage to sample containers or microbiological plates, and signs of contamination. Sample identifiers are also checked against the chain of custody papers. Samples are logged into our log book noting the provider's sample identification number, provider ID, sample type, study ID, sample site, sample collection date, sample arrival date.

2. Isolation and purification of E. coli strains from water and fecal samples

Water samples are received in the form of mFC plates, fecal samples arrive in specimen containers. Fecal samples are plated on MacConkey agar and incubated at 35 ° C, overnight. The next day 3-5 lactose fermenting, non-mucoied colonies are picked and replated on MacConkey agar for purification. Five non-mucoeid blue colonies are picked from mFC plates corresponding to each water sample, are plated on MacConkey agar for purification. At this stage each of the colonies picked from a given sample bears the provider Sample ID number and an accession letter. A single well isolated non-mucoeid colony is picked from each MacConkey plate and is plated on Triptic Soy Agar, after overnight incubation at 35 ° C, each culture is tested by Spot indol test using appropriate positive and negative controls, Indol positive cultures are further tested for the ability to utilize citrate using the Simon Citrate media. Indol positive, indol positive, citrate negative colonies are identified as E. coli and are given isolate numbers.

3. Growing pure cultures of E. coli strains for freezing (long term storage)

A portion of each E. coli strain isolated from the samples will stored at -80° C , in nutrient broth plus 15% glycerol.

4. Isolation of DNA, restriction enzyme digestion and agarose gel electrophoresis of DNA samples

Genomic DNA is isolated from each E. coli strain using a standard protocol. All reagents and buffers are made according to formulas in our SOP. Reagents and buffers are tested for sterility. Every batch of restriction enzyme reaction contains two reactions with our positive control strain which will be included on two lanes on each gel. Agarose gel electrophoresis is conducted under standard conditions, agarose gel concentration, and volume, buffer straight, pH, mA, V, and electrophoresis time are controlled for. Each agarose gel is assigned a number, and when more than one gel is run, the position of the first standard reference strain is changed in each gel (1^{st} lane on the first gel, to the Nth lane on the Nth gel). After electrophoresis gels are stained in ethidium bromide, Each two gels are stained in a single container, of the two gels placed in the same container, one corner of the gel with the higher number is clipped, the labels for each gel is also transferred to the staining container. Each gel is then photographed and a hard copy of the print is labeled with the gel sheet (containing the isolates numbers loaded on each lane, and the enzyme used to cut the DNA, plus date, gel number, voltage, mA, gel strength, buffer strength, and electrophoresis time information) and is kept in the gel b

5. Southern blot hybridization using radio labeled cDNA probe for rRNA genes

Southern blotting is performed according to the protocol detailed in our SOP. After photography each gel is returned to the same staining container. Gels are denatured for Southern blotting in the same container. Each blotting apparatus is set in a separate container which is labeled with the gel number. Each membrane filter is labeled with the gel number, restriction enzyme designation, date, and technician’s initials.

Performance and System Audits

The laboratories selected to analyze samples obtained during this project are assumed to routinely participate in performance and system audits of their laboratory procedures. These laboratories will make the results of these audits available to both the FCD and the funding agency upon request.

Preventative Maintenance

Equipment manuals and standard operating procedures for field and laboratory equipment will be followed closely regarding suggested routine and preventative maintenance. Field and laboratory equipment will be checked upon return to office, or at the end of every sampling period, and will be stored in such a way to minimize damage between sampling periods. A record of routine maintenance will be kept in Microsoft Excel format. Refer to the section containing standard operating procedures for further detail.

Data Assessment

To determine if data quality objectives have been achieved, actual precision and bias will be calculated for each field instrument and laboratory procedure using the equations stated in the section on standard calculations. The data review from the contracted laboratories will document that the laboratory analysis meet stated objectives. A record of precision and accuracy will be kept for field measuring equipment by taking duplicate field measurements. Analytical precision will be calculated using the results of duplicate analysis of sample aliquots. Sample bias will be determined using field blanks.

All laboratory analysis data that do not meet stated quality objectives for precision and bias will be marked as such. Field duplicates that do not meet stated objectives may indicate the need to recalibrate the instrument. Standard operating procedures, and preventative maintenance schedule will be followed to remedy the problem before any more measurements are taken. Invalid data (data not meeting stated quality objectives) will be removed from the data set, and corrective actions will be taken.

The completeness of the project will be determined by dividing the number of samples collected (and not removed due to precision or bias errors) by the number of samples scheduled to be collected. The project will be considered successfully completed if at least 80% of the samples collected for each parameter represent stated quality objectives and scheduled number of samples.

Corrective Action

The laboratories conducting sample analysis for this project have specific quality control procedures that include criteria for initiating corrective action based on Quality Control results. These criteria and proposed corrective action will be made available to the Ferry Conservation District which will then implement any field related sample gathering corrective actions. Sample date and a record of accuracy will be kept for each person taking field measurements. If significant errors occur, standard operating procedures will be followed to recalibrate/repair instrument. If no instrumental problems exist, the person taking the measurement may need to be re-trained in the process of taking field measurements.

Quality Assurance Reports

All raw data will be kept in Microsoft Excel or Access format and available for the DOE to review upon request. A record of accuracy and precision will be kept for all field and laboratory equipment. The final report prepared by the FCD will include a section that summarizes data quality. The DOE will receive quarterly updates of data results, problems, corrections, and results of any system audits.

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Glossary of Terms

Accuracy: Measures the ability of an instrument to hit a given target. Accuracy is determined by analyzing a known standard at random intervals. For example, while taking pH measurements in the field, a staff member will periodically measure a sample of known pH (a check standard). The difference between what the instrument displays and the actual sample is a measure of accuracy. Accuracy is reported as a percentage of error.

Bias: Data collection errors due to the improper handling of samples, calibration of instruments, or contamination of samples.

Best Management Practices: A provision of the Clean Water Act requires land managers to develop Best Management Practices (BMPs) designed to restore the quality of surface waters on 303 (d) listed streams.

Conductivity: Measures the ability of water to conduct electricity. Increased conductivity levels indicate the presence of various salts in water. Erosion and runoff from roads have contributed to increased conductivity levels.

Dissolved Oxygen: Dissolved oxygen is essential for aquatic life forms. The amount of dissolved oxygen in surface waters is intimately associated with all other water quality parameters. Increased temperatures, elevated nutrient levels, and decreased flows can decrease the amount of dissolved oxygen in a stream.

Fecal Coliform Bacteria: Bacteria associated with the gut of warm-blooded animals. The presence of fecal coliform may indicate the presence of disease causing agents.

Geometric Mean: The nth root of a product of n factors ($\sqrt[n]{((x1)(x2)\ldots(xn))}$. Certain environmental measurements are inherently more variable than others. For example, fecal coliform counts (colonies/100ml) can vary from 0 to 8,000. Therefore, the geometric mean is used to get a more "true" estimate of average count.

Nitrogen: An essential nutrient – the fourth most common element found in living cells. An excess amount of nitrogen in surface waters can cause algae to grow out of control which may produce toxic algae blooms, reduce dissolved oxygen, and reduce the clarity of water. Nitrogen is present in surface water in several different forms. The forms most important to this study include:

> **Nitrate (NO_3)**: The most common form of nitrogen in surface waters. Nitrate ions move easily through soils and are quickly lost from the land. Therefore, levels of nitrate in surface waters are closely associated with land use practices within a watershed. Increased nitrate levels indicated disturbed soils.

Ammonia (NH_4): Ammonia is a waste product produced by all animals. It is also the preferred form of nitrogen used for plant growth. Elevated levels of ammonia in surface waters will be quickly converted to plant and algae growth. However, ammonia may become harmful to both plants and animals at elevated pH levels when toxic ammonium hydride forms.

Nitrite (NO_2): Nitrite is a reduced form of nitrate. Nitrate is reduced to nitrite in the absence of oxygen. Therefore, nitrite is usually found in very small quantities in free flowing surface waters. However, polluted streams can contain up to 10 mg/L nitrite below sewage outflows.

Pathogen: A disease causing agent.

pH: A measurement of the amount of acidity or alkalinity of water. A pH reading of 7.0 is considered neutral (not too acidic or basic). A pH reading below 7.0 is considered acidic while a pH reading above 7.0 is considered basic. Factors such as rain and soil types can effect the pH of surface waters.

Phosphorus: An essential nutrient for living cells. On the watershed scale, the inflow of total phosphorous results mainly from the erosion of soils from steep slopes and disturbed ground during storms and floods. Under normal circumstances, the amount of algae in surface waters is directly proportional to total phosphorus levels. High algae levels can produce toxic blooms, reduce light penetration and dissolved oxygen levels, and decrease the aesthetic value of surface waters.

Precision: Provides a measure of how closely an instrument can repeat a given measurement. Taking a certain percentage of all measurements in duplicate, and recording the difference between duplicated measurements determines precision. Precision is reported as relative standard deviation (RSD). For most environmental measurements, an RSD of 5 % or less is acceptable.

Riparian Area: Lands adjacent to streams and lakes where vegetation is strongly influenced by the presence of water. Riparian areas have physical and biological attributes that can influence water quality. For example, healthy grasses in a riparian area physically filter and remove potential stream contaminants from runoff water. The grass itself is a biological factor. Stream temperatures and flow regime have been closely associated with the health of riparian vegetation.

Stream Flow: Stream flows are closely associated with the health of a watershed. Changes in stream flow over time may indicate changes in land use practices.

The Clean Water Act: The Clean Water Act is a 1977 amendment to the Federal Water Pollution Act of 1972. This law sets the basic structure for setting water quality standards for all surface water contaminants. The Environmental Protection Agency (EPA) is the regulatory agency overseeing this law.

The 303 (d) List: In accordance with section 303 (d) of the Clean Water Act, every two years each state must identify its polluted water bodies and submit this list to the EPA (the 303 (d) list). The Washington State Department of Ecology (DOE) sets the standards by which surface waters are judged.

Turbidity: Turbidity is a measure of how clear, or not clear (turbid), surface waters are. Increased turbidity levels will decrease light penetration and have a negative effect on aquatic organisms. Soil disturbance has been known to "muddy up" a stream during storm events.

Watershed: A stream's watershed consists of the land area from which a stream gathers its water. Watershed boundaries are usually defined as ridge tops where water can only flow downhill in a particular direction towards a particular stream.

Appendix A

Letters to local landowners and agencies concerning the formation of the Kettle Tri-Watershed Management Team (KTWMT)

January 13, 2000

Dear Landowner:

We believe that local leadership is vital to studies concerning the health and welfare of our streams and way of life here in Ferry County. You may not be aware that ------------ Creek has been listed under the Clean Water Act 303 (d) list as exceeding state standards set by the Department of Ecology for fecal coliform concentrations. Fecal coliform bacteria are generally associated with the feces of warm-blooded animals, including humans. High levels of fecal coliform may indicate the presence of more harmful pathogens.

Due to the listing of ----------------- Creek and others along the Kettle Range, the Ferry Conservation District will be studying the entire watershed to determine the source and extent of fecal contamination, and characterize overall water quality. Ultimately, our goal is to restore the extraordinary water quality of this stream and have it removed from the threat of future restrictions by implementing locally initiated voluntary management practices.

The Ferry Conservation District is forming the Kettle Tri-Watershed Management Team that will consist of local private landowners, and representatives from state and private agencies. This team will provide guidance and local insight in the design and implementation process of this project. The first management team meeting is scheduled for February 9, 6:00 pm at ----------------. If you are interested in being part of this team, contact the Ferry Conservation District at

Phone: (509) 775-3473
E-mail: randy-williams@wa.nacdnet.org

Additionally, we are interested in hearing from local persons who can participate in monitoring activities. For example, we have rain gauges that can be conveniently placed and monitored with little effort. Training will be provided.

Sincerely,

Chris Tretter
Water Resource Specialist

January 17, 2000

Dear --------:

Ferry Conservation District (FCD) will be facilitating the initial Kettle Tri-Watershed Project (KTWP) Management Team meeting on February 9, 2000 at 6:00 p.m. at the Curlew Civic Center. FCD would like to invite and encourage representation from your organization/agency as a participant on the Management Team. The Management Team will serve in an advisory capacity to provide guidance to the quality assurance project plan, correlation of monitoring data, and provision of recommendations for Best Management Practices to be implemented based on study findings.

A copy of the outline of objectives for the project is enclosed for your reference. Ferry Conservation District will be studying Lone Ranch, St. Peters, and Lambert Creek, due to listing on the Clean Water Act 303(d) list within the Kettle Range, to determine the source and extent of fecal contamination, and characterize overall water quality. Our goal is to involve landowners with agencies and organizations in determining current status of these watersheds and to provide both short and long term solutions for land use management.

Thank you for your consideration of this request and please contact our office if we may be of further assistance. You may call or e-mail me at the following:

Phone: (509) 775-3473
E-mail: randy-williams@wa.nacdnet.org

Sincerely,

Randy Williams, District Manager

Appendix B

Guidelines for facilitating the Kettle Tri-Watershed Management Team meetings.

KTWMT Meeting Guidelines and Assessment
Adopted from the Annual WACD Conference – 1999

General Considerations (staff):

1. Define goal of meeting (what do we want to accomplish during the meeting, and is our goal realistic).

2. Make sure goal can be accomplished in one meeting.

3. Develop an agenda with time frames.

4. Develop a discussion outline.

5. Arrive at meeting place early enough to set up audio/visual equipment, tables, chairs, make coffee, etc.

Meeting Considerations:

1. A good meeting starts and finishes on time.

2. Group members should introduce themselves.

3. Discuss housekeeping items (scheduled breaks, restroom location, etc.)

4. Make sure everyone participates.

5. Stimulate, guide, and control discussion.

6. Accurately capture comments.

Before adjourning:

1. Firm up decisions.

2. Make assignments for pending work items.

3. Set up next meeting times, dates, purpose.

Meeting Assessment

Please describe your impression of the meeting just completed. Circle the number on the scale that describes your opinion of the meeting.

1. PURPOSE OF THE MEETING

Purpose was unclear; Caused confusion	1 2 3 4 5	Purpose was very clear; understood by all

2. STRUCTURE OF THE MEETING

No clear structure; Seemingly random Events	1 2 3 4 5	Well organized; Logical flow of events

3. PLAN AND DESIGN OF THE MEETING

No agenda; Incomplete agenda; misspent	1 2 3 4 5	Agenda available in advance; time well Time used

4. MEMBERS AND ATTENDANCE

Members absent; Members inattentive, Disruptive	1 2 3 4 5	All needed members present; members assumed appropriate Roles

5. LEADERSHIP OF THE MEETING

Leader failed to lead; Lost control	1 2 3 4 5	Active, helpful facilitation; leader Prepared

6. PARTICIPATION IN THE MEETING

A few dominated; Many did not Participate	1 2 3 4 5	Open exchange of ideas; all participated actively

7. MY CONTRIBUTIONS TO THE MEETING

Little participation; My contributions Ignored	1 2 3 4 5	Active participation others considered my ideas

8. LOGISTICS

Time and place of meeting Discouraged Attendance	1 2 3 4 5	Time and place of meeting assisted the group

9. DECISIONS MADE/ACTIONS TAKEN

Decisions not made; Decision-making Process unclear	1 2 3 4 5	Decisions were made; took action; clearly made progress

10. OVERALL PRODUCTIVITY OF MEETING

Little accomplished; Time wasted; not Focused	1 2 3 4 5	Efficient and effective; used time very well

COMMENTS:

THANK YOU FOR YOUR FEEDBACK ON THIS MEETING!

Appendix C

Standard forms and methods for monitoring and describing riparian and upland conditions.

Standard Checklist

Name of Riparian-Wetland Area: ____

Date: __________ Area/Segment ID: ________________ Miles: ___________________

ID Team Observers: ____

YES	NO	N/A	HYDROLOGIC
			1) Floodplain inundated in "relatively frequent" events (1-3 years)
			2) Active/stable beaver dams
			3) Sinuosity, width/depth ratio, and gradient are in balance with the landscape setting (i.e., landform, geology, and bioclimatic region)
			4) Riparian zone is widening or has achieved potential extent
			5) Upland watershed not contributing to riparian degradation

YES	NO	N/A	VEGETATIVE
			6) Diverse age-class distribution (recruitment for maintenance/recovery)
			7) Diverse composition of vegetation (for maintenance/recovery)
			8) Species present indicate maintenance of riparian soil moisture characteristics
			9) Streambank vegetation is comprise of those plants or plant communities that have root masses capable of withstanding high stream flow events
			10) Riparian plants exhibit high vigor
			11) Adequate vegetative cover present to protect banks and dissipate energy during high flows
			12) Plant communities in the riparian area are an adequate source of coarse and/or large woody debris

YES	NO	N/A	SOILS-EROSION DEPOSITION
			13) Floodplain and channel characteristics (i.e., rocks, overflow channels, coarse and/or large woody debris) adequate to dissipate energy
			14) Point bars are revegetating
			15) Lateral stream movement is associated with natural sinuosity
			16) Systems is vertically stable
			17) Stream is in balance with the water and sediment being supplied by the watershed (i.e., no excessive erosion or deposition)

Remarks

____
____
____
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____

<u>Summary Determination</u>

Functional Rating

Proper Functioning Condition ________________
Functional—At Risk ________________
Nonfunctional ________________
Unknown ________________

Trend for Functional—At Risk

Upward _________________
Downward _________________
Not Apparent _________________

Are factors contributing to unacceptable conditions outside BLM's control or management?

Yes ______________
No ______________

If yes, what are those factors?

____ Flow regulations ____ Mining activities ____ Upstream channel conditions
____ Channelization ____ Road encroachment ____ Oil field water discharge
____ Augmented flows ____ Other (specify) ___________________________________

<table>
<tr><td colspan="5">Watershed Condition Inventory for
Soil and Water Improvement</td><td colspan="2">Project Name:</td></tr>
<tr><td colspan="7">Location</td></tr>
<tr><td colspan="4">Watershed:</td><td colspan="3">___¼ of ___¼ of section____ of Township___,
Range______</td></tr>
<tr><td colspan="7">Topography</td></tr>
<tr><td colspan="2">Slope:</td><td colspan="2">Aspect:</td><td colspan="3">Accessible by Machinery: yes no</td></tr>
<tr><td colspan="7">Soil Resource Inventory (SRI) Classification:</td></tr>
<tr><td colspan="7">Remarks:</td></tr>
<tr><td colspan="7">Nature of Problem</td></tr>
<tr><td colspan="7">1. Erosion: ☐ Sheet ☐ Rill ☐ Gully ☐ Streambank ☐ Channel ☐ Abandoned Road</td></tr>
<tr><td colspan="6">2. Stability: ☐ Slump ☐ Landflow ☐ Debris Slide</td><td>3. Other:</td></tr>
<tr><td colspan="7">4. General Cause: ☐ Natural ☐ Management Related</td></tr>
<tr><td colspan="7">5. Condition Trend: ☐ Improving Naturally ☐ Remaining Uniform ☐ Worsening rapidly</td></tr>
<tr><td colspan="7">6. Specific Cause:</td></tr>
<tr><td colspan="7">7. Area/treatment units: ______(yrd)^3 _____Acres _____Miles</td></tr>
<tr><td colspan="7">8. Description of Problem:</td></tr>
<tr><td colspan="7">Degree of Impact on Resources</td></tr>
<tr><td>Resident Fish</td><td>Wildlife</td><td>Range</td><td>Timber</td><td>Water</td><td>Recreation</td><td>Soil Productivity</td></tr>
<tr><td>L M H</td><td>L M H</td><td>L M H</td><td>L M H</td><td>L M H</td><td>L M H</td><td>L M H</td></tr>
<tr><td colspan="7">Recommended Action:</td></tr>
<tr><td colspan="6">Signature:</td><td>Date:</td></tr>
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